CONFERENCE ON EDIBLE FATS AND OILS

USDA Utilization Research and Development Representatives
and Technical Committee of
Institute of Shortening and Edible Oils, Inc.

On February 2-3 Representatives of the four Utilization Research and Development Divisions and the Washington office of the U. S. Department of Agriculture met with the Technical Committee of the Institute of Shortening and Edible Oils, Inc. to discuss utilization research in the field of edible fats and oils and to exchange ideas of future research needs of the industry. During the first day, highlights were presented of the research being done in this field by each of the USDA Utilization Research Divisions. The second day was largely devoted to discussions by the Technical Committee on research needed by the industry.

This report summarizes the principal research activities in progress at each of the respective Utilization Divisions believed to be of interest to the Technical Committee, and includes information which, due to lack of time, could not be given at the meeting. A list showing participants in the meeting is attached.

Dr. George W. Irving, Deputy Administrator of the Agricultural Research Service, USDA, presided at the first day's conference; Dr. Karl F. Mattil, Swift and Company, chairmaned the second day's meeting.

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service

Meeting with Technical Committee of Institute of Shortening and Edible Oils, Inc.

February 2 and 3, 1959

Attendance List

U. S. Department of Agriculture

Office of Administrator:
Dr. George W. Irving, Jr., Deputy Administrator
Dr. John R. Matchett, Assistant to Administrator
Mr. A. Mason DuPre, Assistant to Administrator
Dr. J. E. Simpson, Assistant to Deputy Administrator

Eastern Utilization Research and Development Division:
Dr. Waldo C. Ault, Chief, Animal Fats Laboratory
Mr. R. W. Riemenschneider, Animal Fats Laboratory

Southern Utilization Research and Development Division:
Mr. T. H. Hopper, Chief, Industrial Crops Laboratory
Mr. R. O. Feuge, Industrial Crops Laboratory

Northern Utilization Research and Development Division:
Dr. H. J. Dutton, Oilseed Crops Laboratory

Western Utilization Research and Development Division:
Dr. G. O. Kohler, Chief, Field Crops Laboratory
Dr. L. A. Goldblatt, Field Crops Laboratory

Institute of Shortening and Edible Oils, Inc.

E. W. Brockenbrough, President, Institute of Shortening and Edible Oils, Inc.

Technical Committee:
Dr. Karl F. Mattil, Chairman, Swift and Company
Dr. R. R. Allen, (alternate for Mr. W. J. Jacob), Anderson, Clayton & Co., Foods Division
Mr. R. J. Vander Wal, Armour and Company
Mr. V. K. Babayan, E. F. Drew & Company
Mr. T. A. Meyer, (alternate for Mr. W. M. Cochran), The Glidden Company
Mr. S. J. Rini, HumKo, Div. Nat'l Dairy Products Corp.
Dr. J. D. Justice, Lever Brothers Company
Mr. J. S. Brod, The Procter & Gamble Company
Dr. H. D. Royce, Wesson Oil & Snowdrift Company, Inc.
Mr. H. T. Spannuth, Wilson and Company, Inc.

 C O P Y

RESEARCH IN FOOD FATS AND OIL; TRIGLYCERIDE COMPOSITION AND MINOR COMPONENTS.

Dr. R. J. Vander Wal

To satisfy today's requirements food fats must be more than sources of energy, carriers for fat soluble vitamins, and dietary elements lending palatability to foods and providing a feeling of satiety to the consumer. Fats today have certain specialized functions in the preparation and properties of foods which to a large degree are related to their fatty acid composition and their molecular structure. Among the plastic shortening fats at least, the functional character is largely determined by the kinds and proportions of the fatty acids present and the manner in which they are associated within and among the various molecules. These factors may also prove important in the liquid and semi-liquid forms used in baking and for deep fat cookery.

The nutritional qualities of fats are now also under scrutiny and in this area also their fatty acid composition is of primary importance. Up to this point molecular structure and composition have not been given much consideration in this respect, but it would not be wise to predict that these factors will not some day prove of importance in nutrition.

The ranges of fatty acid composition of the common natural food fats now on record in the literature have been determined mostly by methods less sensitive than those now in use, and which in some cases have been shown to be unreliable. Even the data which will be published soon by the Technical Committee of the Shortening Institute, and which we feel is reliable, will include no breakdown of the saturated acid components in the most common food fats.

My first suggestion for research of value to those concerned with the characteristics of fats and oils is, then, the accurate determination of the ranges and reliable averages of the component fatty acids of fats of known or potential nutritional or food value. Fats from plant sources which may be valuable substitute crops should by all means be studied. So also should the fats from various animal tissues such as bone marrow, blood and nervous tissue which may have special nutritional or physiological significance.

I said earlier that the structural relationships between the constituent fatty acids within and among the molecules are of importance. Food fats in general are made up of several different fatty acid components and these may be combined as triglycerides in a multiplicity of ways. To determine the proportions of each kind of molecule present in a fat would therefore be a stupendous job. If, however, all saturated components are considered as a group and all unsaturated ones are considered as another group, all fat molecules fall into one of four catagroies known as glyceride types, and the job of analysis is simplified.

If the proportions of the glyceride types and their isomeric forms could be readily determined in any kind of fat, natural or otherwise, it would be easier to formulate fats designed for specific purposes. If besides knowing the proportions of the various molecular species in a fat mixture, we also could foretell how they would interact to determine the physical properties of the fat, our task would be still easier.

My second suggestion, then, consists of two parts (a) that improved methods be sought for determining the type composition and proportions of symmetrical isomers in any fat, whether it be a natural one or otherwise and (b) that the inter-relationship of these various forms as manifested in the physical and performance characteristics of fats be found.

Some constituents other than the glyceryl tri-esters of fatty acids are found in minor proportions in most, if not all, natural fats. Among the minor constituents which may be present are sterols of various kinds, phenolic substances which like gossypol have anti-oxidant activity, phosphatides, pigments and flavor constituents.

The presence of these substances has presented no great problem in the use of such fats for food but there are two areas in which their effect might well be explored.

The first of these is the effect of these constituents in the formation of toxic or otherwise harmful substances resulting from heating fats containing them at high temperatures as in deep fat frying. They may themselves contribute some toxic or otherwise harmful substances when degraded by heat. They may also take part in reactions involving the unsaturated fatty acyl groups. It is possible that they may act as either catalysts or inhibitors in polymerization reactions.

My fourth suggestion therefore is that the effect of these minor constituents, singly and in combination, on the development of toxic or otherwise harmful principles in fats heated to high temperatures both in air and in the absence of air be investigated.

Finally these minor constituents may have some physiological importance. As an example, the non-saponifiable fraction of bovine yellow bone marrow appears to have some stimulating effect on white-blood cell formation and may be useful in treatment of white blood cell deficiency.

It may not be in the province of the USDA to do this kind of study but I shall nevertheless advance the suggestion that the physiological value of the minor constituents of fats be investigated.

1-28-59.

EASTERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

Dr. Ault indicated that over one hundred representatives of industry organizations visit Eastern Utilization Laboratory annually to be kept informed of its research progress and plans. He pointed out principal methods of disseminating such information, for example, through scientific publications, trade journal articles, participation in industry and technical meetings, and active liaison with companies interested in using products and processes developed at EU. Dr. Ault emphasized that empirical methods of research have gone as far as practical in developing new uses for fats and oils. He further stressed that, particularly for chemical and industrial uses, functional purity rather than chemical purity was required. His discussions mostly concerned work on increased industrial uses for fats and oils.

Mr. Riemenschneider's discussion was devoted largely to research on edible fats and oils. He reviewed some of EU's contributions to improving analytical methods, compositional studies of some of the fatty acids, synthesis of certain glycerides, and pointed out the significance of reactions between fat peroxides and other food constituents as related to flavor characteristics.

Basic research is being done at the Eastern Division to determine compositional characteristics of the various chemical constituents of fats and oils. These investigations entail chemical, physical, physiological and other factors. Some of this work is done cooperatively with other groups.

Synthesis of Glycerides of Known Structure: Fundamental studies are being made on physical and chemical properties of pure glycerides containing saturated and unsaturated fatty acids in known positions as a requisite in the development of improved processes for producing fats for specific uses and in the development of better methods for determining glyceride composition of natural fats and oils.

Methodology of Lipid Fractionation and Analysis: EU investigations have resulted in the development of an improved, reproducible method for extraction of lipids from small amounts of plasma and determination of the polyunsaturated fatty acid constituents; improved chromatographic separation of component lipids of tissues and determination of fatty acid composition of the components; and demonstration of the applicability of these procedures to various types of tissues such as plasma, atheromatous plaques, liver, and skin, in cooperative work with local medical research groups.

Carbonyls in Oxidizing Fat: Work is in progress to develop a rapid paper chromatographic method for the separation of compounds derived from oxidized fat which could be used to characterize the chemical changes resulting from oxidation. This method is now applicable both to the separation of individual compounds within a homologous series, and to the separation of compounds into classes. Studies are in progress on pork fats utilizing these new techniques.

Action of Microorganiams on Fat: The breakdown of fat is one of the more common deteriorative changes at low temperatures and the most serious factor affecting the acceptability of frozen meat. Much of the work on this project during the past year has been directed toward studying the effect of temperature on the lipolytic activity of bacteria affecting fat deterioration.

Peroxide Studies: The kinetics of decomposition of lauroyl peroxide and pelargonyl peroxide in various solvents have been determined. The decompositions are predominantly first order.

Recent EU Publications

1. "The stability of depot fat from broilers fed rations containing animal fats treated with various antioxidants," by A. J. Siedler, Sheldon Moline, B. S. Scheigert and R. W. Riemenschneider, Poultry Sci. 36, 499-50 (1957).

2. "Technology of animal fats," by W. C. Ault, Progress in the Chemistry of Fats, 5, 26307 (1958).

3. "Peroxides. V. kinetics and products of decomposition of perlauric acid," by Winfred E. Parker, Lee P. Witnauer and Daniel Swern, J. Am. Chem. Soc. 80, 323-7 (1958).

4. "Volatile saturated aliphatic aldehydes in rancid fat," A. M. Gaddis and Rex Ellis. Science, 126, (3277), 745 (1957).

5. "Action of phosphates in sausage products. II. Pilot Plant studies of the effects of some phosphates on binding and color," C. E. Swift and Rex Ellis. Food Technology, 11, (8), 450 (1957).

Recent EU Patents

1. "Process for making fatty peracids," by Daniel Swern and Winfred E. Parker. U. S. Patent 2,813,885 (November 19, 1957).

2. "Production of lanolin alcohols," by Waldo C. Ault, Abner Eisner and John T. Scanlan. U. S. Patent 2,824,143 (February 18, 1958).

3. "Separation of mixed fatty acids," by Daniel Swern and Winfred E. Parker. U. S. Patent 2,838,480 (June 10, 1958).

NORTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

Dr. Dutton presented highlights of research at the Northern Division covering industrial and food uses of oils. Some of the work on linseed oil was briefly reviewed as a matter of background information. He emphasized the work being done on soybean oil, and reviewed research on the flavor problem and how the use of chromatography and radioactive tracers had facilitated these studies. He especially discussed some of the studies for removal of linolenic acid and methods for inhibiting oxidative changes.

Phytoglycolipide from Phosphatides: Studies on the composition of phosphatides is being done under contract at the University of Illinois. Soybean phosphatides were found to contain about 5 percent of the new sphingolipide which has been isolated in pure form, and its structure determined.

Glyceride Composition of Oils: Use of the automatic countercurrent distribution apparatus for separating the component glycerides of vegetable oils has continued. Distribution of fatty acids in the triglycerides of linseed oil and soybean oil have been found to occur in a random pattern rather than in an even pattern as previously supposed.

These studies lead to the conclusion that liquid vegetable oils are constructed in a random pattern. This may mean that potential processes designed to separate pure triglycerides from the naturally occurring mixture has a calculable limit which may be approached.

Improved Gas Chromatographic Method for Fatty Acids: In continuation of research on the instrumentation and methodology of gas chromatography for high temperature application, pioneered by NU, an ion chamber accessory to gas chromatography equipment has been developed which permits the simultaneous tracing on two separate recorders of the (1) concentrations of radioactivity in the fatty acid esters together with (2) the amount of fatty acid ester. In separation already performed, it has provided new information on the labeling of fatty acids with amazing speed and facility compared to all other available methods.

Selective Hydrogenation of Linolenic Acid: Linolenic acid occurs in soybean oil to the extent of 6 to 9 percent and is believed to be the component responsible for the development of off-flavor in edible soybean oil. One approach to a solution of the off-flavor problem is to selectively hydrogenate one of the 3 double bonds in linolenic acid, and thus convert it to a more stable form. The selective hydrogenation work, under contract with the Southwest Research Institute, has been designed to explore the selectivity of four different catalysts for hydrogenation carried out under a variety of conditions.

Oxidative Stability of Soybean Oil: The oxidative instability of soybean oil is known to be accentuated by the presence of metals, especially copper and iron. Some success in stabilizing the oil to oxidative changes has been achieved by adding metal chelating agents such as citric, tartaric, and phytic acids.

a. Autoxidation Studies: Recent studies have shown that trace metals are tightly complexed with oils and that these complexes are strong prooxidant catalysts. The complexing agents for trace metals appear to be trace hydroperoxides or related oxidation products. Upon heating, the complex breaks down, liberating the metal which is then more easily complexed by an added metal complexing agent.

Stability studies have shown that mild heating or processing under deodorization conditions rapidly destroys hydroperoxides present in the fat. Peroxides are decomposed easily by heat into nonvolatile polymeric materials, primarily dimeric in nature, which are stable to heat and remain dissovled in the fat. Based on studies with pure esters the amount of polymer present in oils appears to be a direct and linear function of the amount of peroxides present in the fat prior to deodorization or heating.

b. Radioactive Tracer Analyses: Fatty acids have been labeled by gaseous tritium and these tagged acids of high specific activities have found application in NU oil research. Because unsaturated acids are labeled by addition to a double bond rather than substitution and are converted to the next more saturated isologue, their applicability is restricted. This conversion permits their isolation with extremely high specific activities. The discovery that tritium adds to double bonds during the gas exposure procedure is important to biological and pharmaceutical research where users of the labeled complex molecules have assumed that only substitution takes place and that the biological activity is therefore unaltered.

Pure Linolenic Acid Available: For the first time a practicable method of preparing laboratory-size samples of "natural" linolenic acid is available. Availability of the pure product permits a more realistic approach to basic studies on its reactions and properties.

Soybean Proteins: Fundamental investigations on soybean proteins have continued. A method has been devised for removing the phytate, and for determining the nucleic acids in these proteins. The phytate-free proteins were found to contain three resolvable components by ultracentrifugal studies.

Alleged Antithiamin Factor of Soybeans: Investigations to determine whether soybeans contain an alleged thiamin (vitamin B_1) destroying factor have been concluded. The alleged factor was shown to be an analytical artifact peculiar to the method used by previous investigators. The instability of thiamin in soybean oil meal at a neutral pH, especially on cooking, is similar to that in other foods and feeds. Such instability cannot be attributed to an "antithiamin factor" peculiar to soybeans. With soybeans, this instability was shown to be associated with a metal-catalyzed oxidation.

Flash Desolventizing Hexane-Extracted Soybean Oil Meal: Conditions have now been developed for flash-desolventizing hexane-extracted soybean meal without denaturing the protein. These "soybean protein flakes" have a water-soluble nitrogen value of 87 to 90 percent compared to 70 to 79 percent for flakes produced by present commercial desolventizers. Information on process design and operating data for the 150-pound-per-hour pilot plant is now available.

Cocoa Butter and Replacement Fats: The development of a suitable replacement for cocoa butter required detailed knowledge of the composition and structure of cocoa butter. For the first time such detailed information is available.

Recent NU Publications

1. "An ultracentrifugal study on the association-dissociation of glycinin in acid solution," Joseph J. Rackis, A. K. Smith, G. E. Babcock, and H. A. Sasame. J. of Amer. Chem. Soc. 79(17): 4655-4658. September, 1957.

2. "Vegetable protein isolates," A. K. Smith. In "Processed Plant Protein Food Stuffs," edited by Aaron M. Altschul, pp. 249-276, Academic Press Inc., New York. May, 1958.

3. "Toxic protein from trichloroethylene-extracted soybean oil meal," L. L. McKinney, F. B. Weakley, R. E. Campbell, A. C. Eldridge, J. C. Cowan, J. C. Picken, Jr., and N. L. Jacobson. J. of Amer. Oil Chemists' Soc. 34(9): 461-466. September, 1957.

4. "A modified indophenol-xylene extraction method for the determination of ascorbic acid in soybeans," F. B. Weakley and L. L. McKinney. J. Amer. Oil Chemists' Soc. 34(6): 381-384. June, 1958.

5. "Separation of the Oxidation Products of Fatty Acids by Means of Gas-Liquid Partition Chromatography," Janina Nowakowska, E. H. Melvin and Richard Wiebe. J. Amer. Oil Chemists' Soc. 34(8): 411-414. August, 1957.

6. "Influence of Heat of Oxidative Stability and on Effectiveness of Metal-Inactivating Agents in Vegetable Oils," Patricia M. Cooney, C. D. Evans, A. W. Schwab, and J. C. Cowan. J. of Amer. Oil Chemists' Soc. 35(4): 152-156. April, 1958.

7. "Periodate-Permanganate Oxidations for Determining Location and Amount of Unsaturation in Monounsaturated Fatty Acids," E. P. Jones and J. A. Stolp. J. Amer. Oil Chemists' Soc. 35(2): 71-76. February, 1958.

8. "Progress in Soybean Research," J. C. Cowan. Soybean Digest 17(11): 64-66. September, 1957.

Recent NU Patents

1. "Manufacture of emulsion-type sausages," Elmer F. Glabe. U. S. Patent 2,803,547. August 20, 1957.

2. "Manufacture of sausages," Elmer F. Glabe. U. S. Patent 2,816,035. December 10, 1957.

SOUTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

Mr. Hopper first reviewed the research program on industrial oils, particularly tung oil. He described some of the work on the chlorination of tung oil and its possible usage in rigid plastics, the use of tung oil derivatives to give special properties to paints and to make fugitive emulsifiers. He pointed out that the basic research was being extended to pilot plant work to produce samples for commercial evaluation, to determine suitability of processes, and to obtain production cost data. In the cottonseed oil investigations the importances of color control and research on methodology of measuring color were briefly discussed.

Mr. Feuge confined most of his remarks to research on edible oils. He particularly discussed the work on confectionery fats--melting points and ranges, compatibility, permeability to moisture and evaluation of hardness. He reviewed the importance of tempering as a factor in changing melting points. He gave highlights of the hydrogenation studies and pointed out that in these reactions the effect of temperature was more important than the kind of catalyst in affecting distribution of double bonds. He briefly reviewed the investigations of fats containing dibasic acids for use in food coatings where high gloss and minimum crystallization were desired. The SU research on developing methods for measuring digestibility of fats through use of microorganisms from cottonseed was mentioned. Mr. Feuge concluded his remarks by pointing up the research work on fat emulsions for intervenous use which is being done cooperatively with the Surgeon General's office.

Development of New Hydrogenation Techniques: Research is being done on hydrogenation to obtain a better understanding of the reactions involved and to devise means of controlling them. Results indicate that in hydrogenating cottonseed oil the rate of formation of positional isomers of the oleic acid group was unexpectedly large and many different isomers were formed. Changing the conditions of hydrogenation over the ranges ordinarily encountered in commercial practice had little effect on the rate or types of isomers produced.

Different hydrogenation catalysts, when used under ordinary and identical conditions to half-hydrogenate the linoleic acid group, produced almost identical patterns of distribution of the residual double bonds.

Apparently by varying the conditions of hydrogenation, the composition of an oil, hydrogenated to a given degree, can be varied markedly. Additional information of the type obtained should provide a broad basis for the development of methods for producing new and superior edible fat products.

Biological and Chemical Hydrolysis of New Fats: The purpose of this work is to investigate the hydrolysis of processed and synthetic fats to obtain information pertinent to the acceptance of such fats in foods. A highly lipolytic microorganism, previously isolated from cottonseed is being utilized in comparative studies of synthetic triglycerides and naturally-occurring triglycerides.

Purification of Long Chain Unsaturated Fatty Acids: The objective of this program is to obtain fundamental solubility, freezing point, and phase relation data on the pure amides and substituted amides of the unsaturated fatty acids of vegetable oils and molecular compounds thereof in order to establish a basis for research and industrial methods of purification and end-use of these long chain fatty acids, thereby extending the utilization of the natural oils in the manufacture of edible and nonedible products.

Correlation of Solubility Data for Homologous Long Chain Compounds: The theoretical analysis which led to the development of two interpolative graphical methods for predicting the solubilities of members of homologous series obtainable from glyceridic fats and oils has been continued in order to provide further means of aiding research on utilization of fatty acids and their derivatives. It has been shown that the two methods complement each other so that solubility prediction can now be applied to a greater number of homologous series and solvents, and extended over a wider range of temperature and concentration. The method has proved to be valid even for systems in which the solute and solvent combine to form molecular compounds.

A new equation has been derived relating the solubilities of the odd and even carbon atom members of a homologous series in a given solvent and at a given temperature. If accurate solubility data are available for the even members and for a few odd members of a homologous series, this new correlation makes it possible to predict the solubilities of the missing odd members.

Edible Polymeric Fats: Modified fats prepared from ordinary glycerides and short-chain dibasic acids have been found to possess a range of properties which should make these modified fats highly useful in the food industry. Viscosity can be increased over that of ordinary fats to almost any desired value. Some of the modified fats are hard waxes while others are liquid oils which will not crystallize at low temperatures. All should be edible.

Characterization and Production of Confectionery Fats: The objectives of the investigations on confectionery fats, supported in part by a Fellowship of the National Confectioners' Association, are to develop fundamental information on the behavior of confectionery fats; to devise procedures for obtaining the best performance from such fats, including those derived from domestic oils; and to develop processes for converting cottonseed oil into improved confectionery fats.

Cocoa butter contains two fat components. Because any confectionery fat made from domestic oils should preferably contain a large proportion of these components, they have been synthesized and their properties are being determined. Each component has three distinct melting points, and there is some evidence of the existence of other polymorphic forms not associated with these melting points. The ease of transformation from one melting form to another varies greatly.

The passage of moisture through chocolate coatings and confectionery fats, which results in the drying out of candy centers, is the source of a serious problem, and is being investigated. By using completely hydrogenated cottonseed oil and liquid cottonseed oil, it has been domonstrated that the rate of passage of moisture through a film of fat is affected greatly by the proportion of liquid phase. The polymorphic form of the fat also appears to have a large effect. The presence of the usual nonfat solids found in chocolate candy, including sugar, decreased the permeability to moisture, provided the relative humidity is below about 75%.

Improved Fat-Containing Confections for Armed Forces: Work has been performed to develop for the armed forces chocolate-type coatings and bars which meet the following requirements: (1) contain domestic fats, at least in part; (2) resist melting and deterioration at summer temperatures; and (3) an acceptability (mouthing quality, appearance, etc.) equal to that of those formulated with cocoa butter.

Experiments have indicated that a confectionery fat melting sharply at a temperature somewhat above the melting point of cocoa fat would not be satisfactory even when emulsifiers were added. Studies have been conducted to improve chocolate type confections by incorporating completely hydrogenated cottonseed oil.

Cottonseed Oil Color Measurement: In the investigations on cottonseed oil color measurement, crude oils obtained through cooperation of the industry were refined and bleached in accordance with the trading rules of the NCPA by official methods of the American Oil Chemists' Society. The research seeks to find means for correlating certain analytical data on the original crude oil with color attained after refining; such a correlation would be useful in predicting color of the refined product before actual processing.

Means of Improving Color of Cottonseed Oil: This investigation is directed toward finding means of improving the color of these cottonseed oils found difficult to refine and bleach by current commercial methods. It has been found that the initial phase of the development of alkali-fast coloration is the fixation of gossypol, to yield a yellow alkali-fast pigment; this pigment undergoes a change in color from yellow to red.

Chemical Composition Related to Nutritive Value of Cottonseed Meals: Evidence has been accumulated which indicates that a large part of the variation in the growth response of broilers fed cottonseed meal-containing rations can be accounted for by the variations in the lysine content of the meals. A rapid method for lysine analysis has been developed and applied to many cottonseed meals and other proteinaceous materials. Positive correlations have been obtained between the growth response of broilers and the free epsilon-amino groups of lysine in cottonseed proteins. It has been possible, through the use of this new analytical procedure to demonstrate that gossypol adds to the free epsilon-amino groups of lysine in cottonseed protein, and that gossypol takes part in the destruction of lysine.

The use of Protozoa to Study Nutritive Value of Cottonseed Meal: The use of protozoa to estimate the nutritive value of cottonseed meal has been investigated to develop a rapid screening test to facilitate research on improving the nutritive value of cottonseed meal. The holotricha, Tetrahymea puriformus, is a useful organism for this purpose. This micro-animal has the same amino acid requirements as the rat, has no absolute carbohydrate requirement, and the amino acid metabolism follows pathways which are similar to those found for higher animals.

The advantages gained through the use of micro-animals are: (1) the quantities of proteins required are small; and (2) the assay is rapid. The research is continuing in determining changes in the nutritive quality of cottonseed proteins attending chemical and processing treatment of cottonseed for the purpose of developing a standardized screening test.

Use of Chemical Agents and Polar Solvents in Processing Cottonseed: Research is being done on the use of chemical agents and polar solvents in the processing of cottonseed to improve meal quality and utility. Uncooked cottonseed flakes were extracted in the laboratory and pilot plant under various extraction conditions. Conditions were devised whereby the free gossypol content of the meals was substantially reduced and at the same time the lysine was not materially reduced.

Polymeric Derivatives of Cottonseed Oil and Polyhydric Alcohols: Previous work at the SURDD has shown that polymer-type compounds derived from cotton-seed oil and short-chain dibasic acids can be produced so as to possess a number of desirable and potentially useful properties with respect to food uses. All of the products had number-average molecular weights of about 1600. It is possible to prepare similar products having molecular weights high enough to give film-forming properties. The preparation of compounds having low melting points and film-forming characteristics is being investigated.

Chemical Composition vs. Quality of Processed Peanut Products: The purpose of the study is to find the relations between chemical composition and quality factors of processed peanut products. An undesirable quality factor frequently encountered in peanut products is a bitter flavor. Bitter principles having the general properties of saponins have been concentrated from extracts of peanut hearts.

Studies on the effect of heat on peanuts definitely indicate that the heating conditions maintained in screw pressing peanuts for the recovery of oil seriously reduces lysine, an essential amino acid. Similarly, the heating of peanuts during roasting of them in the manufacture of peanut butter also seriously reduces the lysine content of the protein.

Influence of Processing on the Composition and Flavor of Peanut Products: In order that optimum quality of processed peanut products may be realized, contract research is being conducted at the University of Arizona on the factors leading to improvement of the quality of raw peanuts. The quality of the roasted products is being correlated with properties of the raw peanuts.

Recent SU Publications

1. "A simplified method for the preparation of alpha- and beta- eleostearic acids and a revised spectrophotometric prccedure for their determination," by Joan S. Hoffman, R. T. O'Conner, D. C. Heinzelman, and W. G. Bickford. J. Am. Oil Chemists' Society 24(7): 338-42, July, 1957.

2. "Kinetics of the Diels-Adler reaction of the eleostearic acids with maleic anhydride and substituted maleic anhydrides," by W. G. Bickford, Joan S. Hoffman, Dorothy C. Heinzelman, and Sara P. Fore. J. Organic Chem. 22(9): 1080-83, September, 1957.

3. "X-ray diffraction of molecular compounds of long-chain saturated fatty acids. II. Some further observations on the diffraction of molecular compounds of acetamide and long-chain saturated fatty acids," by Robert T. O'Conner, Robert T. Mod, Mildred D. Murray, Frank C. Magne, and Evald L. Skau. J. American Chemical Society 79(19): 5129-32, October 5, 1957.

4. "The reaction of mercaptoacetic acid with methyl linoleate and linoleic acid," by Sara P. Fore, Robert T. O'Connor, and Leo A. Goldblatt. J. Am. Oil. Chemists' Soc. 35(5): 225-30, May, 1958.

5. "Note on gossypol and its relation to color fixation in cottonseed oil," by Leah Castillon Berardi and Vernon L. Frampton. J. Am. Oil Chemists' Society 34: 300-401, August, 1957.

6. "Fat products research. New, special fats for confectionery use. Ms. title: 'Developments in the preparation and characterization of fat products,'" by R. O. Feuge. Candy Industry and Confectioners J. 109(10): 21, 42-43, 53, November, 1957.

7. "The pigments of crude cottonseed oils. II. Nitrogen-containing pigments derived from gossypol," by J. M. Dechary. J. Am. Oil Chemists' Soc. 34(12): 597-600, December, 1957.

8. "The present status of acetoglycerides," by R. B. Alfin-Slater and R. D. Coleman, U. of S.C., and R. O. Feuge and A. M. Altschul. J. Am. Oil Chemists' Soc. 35(3): 122-127, March, 1958.

9. "Incorporation of gossypol into eggs of hens fed gossypol schiff bases," by J. M. Dechary, G. Wakabyaashi and C. R. Grau. J. Am. Oil Chemists' Society 34(11): 548-49, November, 1957.

10. "Determination of free and total gossypol in mixed feeds containing cottonseed meals," by Walter A. Pons, Jr., and Carroll L. Hoffpauir. J. Assoc. Off. Agr. Chemists 40(4): 1068-80, November 15, 1957.

11. "3-amino-propanol as a complexing agent in the determination of total gossypol," by Walter A. Pons, Jr., Robert A. Pittman, and Carroll L. Hoffpauir. J. Am. Chemists' Soc. 35(2): 93-97, February, 1958.

12. "Lysine content of cottonseed meals," by Wilda H. Martinez and Vernon L. Frampton. J. Agr. & Food Chem. 6(4): 312 April, 1958.

13. "The value of cottonseed oils as affected by the degree of oil extraction and the method of meats preparation," by P. H. Eaves, J. J. Spadaro, A. J. Crovetto, and E. A. Gastrock. Oil Mill Gazetteer 62(1): 9-13, July, 1957.

14. "Research on improvement and quality of cottonseed meal and oil," by A. M. Altschul and L. S. Bensabat. Oil Mill Gazetteer 62(4): 9-12, October, 1957.

15. "Oilseed research progress," by T. H. Hopper. Cotton Gin & Oil Mill Press 58(23): 30-33, November 16, 1957.

16. "Pilot Plant development of the alkali cooking process for cottonseed meats. III. Quantitative effect of cooking variables on solubility of meal nitrogen," by W. H. King, N. B. Knoepfler, and Carroll L. Hoffpauir. J. Am. Oil Chemists' Soc. 35(1): 46-49, January, 1958.

17. "Effects of alkali cooking on the yields of crude and neutral oil from cottonseed meats," by P. H. Eaves, L. J. Molaison, N. B. Knoepfler, and J. J. Spadaro. J. Am. Oil Chemists' Soc. 35(1): 33-36, January, 1958.

18. "Opportunities in the future for cottonseed research," by Aaron M. Altschul. The Cotton Gin & Oil Mill Press 59(3): 16,33-35, February, 1958.

19. "Cocoa butter-like fats from domestic oils," by R. O. Feuge and Norman V. Lovegren, SURDD, and H. B. Cosler, QM Food and Container Inst., Chicago, Ill, J. Amer. Oil Chemists' Soc. 35 (5): 194-199, May, 1958.

20. "The preparation and infrared spectra of morpholides of ricinoleic acid and some of its derivatives," by Harold P. Dupuy, Robert T. O'Connor and Leo A. Goldblatt. J. Amer. Oil Chemists' Soc. 35, 99-102 (1958).

21. "Preparations and properties of castor oil urethane foams," by D. A. Yeadon, W. F. McSherry and L. A. Goldblatt. J. Amer. Oil Chemists' Soc. 36, 16-20 (1959).

22. "Ricinelaidic acid and methyl ricinelaidate. Their preparations and determination by infrared spectroscopy," by Marion A. McCutchon, R. T. O'Connor, Elsie F. DuPre, L. A. Goldblatt and W. G. Bichford. J. Amer. Oil Chemists' Soc. 36, 115-118 (1959).

Recent SU Patents

1. "Pretreatment of oilseed meats," by William H. King, U. S. Patent 2,820,047, January 14, 1958.

2. "Purification of long chain fatty acids," by Evald L. Skau, U. S. Patent 2,816,903, December 17, 1957.

PRESENTATIONS BY TECHNICAL COMMITTEE OF INSTITUTE OF SHORTENINGS AND EDIBLE OILS, INC.

The meeting convened at 9:30 a.m., Tuesday, February 3, with Dr. K. F. Mattil as presiding chairman. He analogized that the shortening industry is akin to the ARS Regional Laboratories in that the laboratories came into being because of agricultural surpluses, and the shortening industry started because of agricultural surpluses. He remarked that the shortening industry has been a sort of sponge to absorb some of the agricultural surpluses; but that industry's technology has been ahead of science. Industry simply does not have enough real scientific knowledge about some of the fats and oils materials it is working with.

One of the real serious situations is that there are very few research groups in this country that are working on the basic science of these materials, as industry cannot spend a substantial portion of its budget on fundamental research and at the same time keep up with the technological competition. While industry can do some fundamental research, it primarily has to look to ARS for fundamental knowledge. Industry recognizes there is an important area for work in industrial nonfood uses, but the big use for fats is in food. For example, he premised that should something cause a 10% reduction in food consumption of lard and shortening, the loss in this market (of some 300 to 400 million pounds annually) can create a tremendous surplus of fats.

In view of the urgency to get more fundamental research information, the Institute's Technical Committee met last fall and asked themselves, "What are the areas of research that would help this industry in maintaining the consumption of fats and oils?" From this informal meeting, the Committee has developed a list of the important research areas which the Committee feels are needed to be undertaken. Today's speeches will give a resume of their research needs.

Agricultural Research Under P. L. 480 Program

Prior to the Committee presentations, Dr. Matchett, Assistant to Administrator, ARS, was asked to review the Department's foreign grants and contracts research program being conducted under P. L. 480. According to Dr. Matchett, plans were initiated by ARS of the U. S. Department of Agriculture in 1957 to establish a utilization research and development program in certain European countries under the provisions of P. L. 480, with Dr. G. E. Hilbert as the general director. Such a program was established in 1958 with the placing of grants in England and Israel totaling nearly one and one-half million dollars. Later in the year an office was established as a part of the American Embassy in Rome, Italy for the Administration of the European program, with Dr. Walter M. Scott in charge.

In the early planning, there was evisioned a program of utilization research in six countries--United Kingdom, Italy, France, Spain, Finland and Israel. The favorable potentials of this utilization research program has resulted in Congress also providing authorization for similar research programs in

farm production, marketing, and forestry, with inclusion of Yugoslavia, Poland, and some countries outside of Europe. Preliminary surveys have been made in the Far East, including Indonesia, Pakistan, India, and the Philippines, and in most of the South American countries.

The foreign program will emphasize basic research although, where found desirable, some applied research also will be undertaken. The program is a multi-million dollar enterprise, but just how large it may become is hard to predict at this time.

Research results will be published and made available both here and abroad. Although few projects on fats and oils have been received so far, USDA hopes to undertake this sort of research under the P. L. 480 program. The Technical Committee was invited to offer suggestions for needed research and names of qualified foreign research workers in this field.

Methods of Analysis, Including Validity of Existing Methods

Dr. J. D. Justice discussed a few of the problems being encountered in the industry laboratories and highlighted some of the basic scientific problems and questions that industry would like to see answered by someone in the area of methods of analysis -- infrared, ultra violet, and vapor phase chromatography, etc. Industry feels that Government can make a big contribution in the area of basic research, especially in the field of methodology. It was pointed out that the National Institutes of Health have quite an extensive laboratory for gas chromatography work. Further needed work is to increase sensitivity and resolution, as well as more research in high temperature ranges.

There followed a general discussion, and Dr. Vander Wal expressed the hope that USDA would further extend the research in high temperature analysis and vapor phase chromatography on mono-, di-, and tri-glycerides. He stated that Armour laboratories have been able to distinguish chain lengths up to C_{30}.

Dr. Feuge commented about their work on infrared investigations of solid glycerides and noted there is not much published data on determining the type of glycerides present in mixtures or their polymorphic form. He noted that Dr. Chapman had done some research in this area but, so far as known, has not published details of this work.

Physical Chemistry of Fat Systems

Mr. H. T. Spannuth discussed the physical chemistry of fat systems and stated that their work has been with physical forms of food fats and their end uses. Industry leans heavily of physical tools, but its practices exceed the scientific knowledge of just what occurs. Raw materials are rearranged, hydrogenated, and blended to produce new compounds. Essentially, there are three types of blends: (1) all liquid; (2) all solid; and (3) two in-between groups. He reiterated that industry needs a new handbook of

physical constants for fats and oils. There is need for more investigations of polymorphic forms in the dynamic state, including new methods of evaluation. There are many gaps in the systematic data, for example, dielectric values. Studies are needed on pure and mixed crystals of mono-, di-, and tri-glycerides.

There is need to look for new physical tools and develop data for a "handbook on physical constants" for pure triglycerides to assist industry in meeting the demand for use of surplus products or adjusting to the surpluses or shortages. He pointed out that there is an unprecedented amount of research work being done on the nutritional studies of fats. If this research should eventually indicate a change in the diet, the physical data in such a handbook would be highly welcomed by industry in changing toward new eating habits, if that be the case.

There followed a general discussion. It was stated that some work is being started on the synthesis of certain types of fats. Data on mono-, di-, and triglycerides and solubility data on glycerides is practically nonexistent. It was suggested that we might benefit from the experience of the petroleum industry in the practice of tabulating industry data. Dr. Feuge stated that making up samples for tests is a problem -- he is convinced there is no sure way on certain di-acid and tri-acid glycerides.

Dr. Ault remarked that whether the Government could or could not undertake some of the research work largely rested in the final problems of finding qualified research chemists. The Eastern Laboratory has experienced this difficulty, as well as others, since the petroleum industry (for one) can offer them more money than the ARS Laboratories.

Fat Composition

Dr. R. J. Vander Wal addressed the group on research in food fats and oils, their triglyceride composition and minor components. He stated that fats today have certain specialized functions in the preparation and properties of foods which to a large degree are related to their fatty acid composition and their molecular structure. Food fats in general are composed of several different fatty acid components. He outlined the possibility of 14 different triglycerides that could be formed from the combination of only three fatty acids (stearic, palmitic, and oleic). Obviously, to determine the character of each of these molecules in a fat would not be a practical task. He demonstrated, however, the shortcuts available for determining the character of certain groups thereby simplifying the analysis, i.e., that on the basis of saturated and unsaturated content all fat molecules would fall into one of four categories known as glyceride types.

Dr. Mattil called attention to the Committee's work on the composition of fats data, which information has been put into a table. This tabulation has been submitted to the Journal of the AOCS for publication, but no word has yet been received from the Journal. He said copies could be obtained from him or through the Institute's office should any care to have it.

Dr. Vander Wal stated that his laboratory has been able to calculate mathematically isomeric forms of the mixed glycerides present in the pig fats, for example, which coincides with other experimental data. (Attached is a paper Dr. Vander Wal prepared for this meeting, which gives more details of his suggestions.)

Mechanism of Chemical Changes in Fats; Influence on Composition and Nutritive Value

Dr. R. R. Allen addressed the group on the mechanism of chemical changes in fats and their influence on composition and nutritive values. He stated that the food fat industry uses very little chemical treatment of fats, but there is one reaction that is used in very large volume -- hydrogenation. But little is actually known abut this reaction. Only in the last few years has there been any study of the mechanism of the hydrogenation reaction, and he feels there is a great need to go much deeper in the study of hydrogenation, e.g., why do different catalysts cause the formation of a different product, what influence is caused by various gases, specific effects of small impurities in the oil, better understanding of specific catalysts, effects of temperature, effect of concentration, and many other factors.

Another important type of reaction is oxidation -- one that usually is avoided, if possible. As an example, he mentioned Dr. Dutton's work on flavor stability of soybean oil. He stated that industrial organizations could carry out the development work on this provided more was known about the basic mechanism of oxidation.

Another problem facing industry is the problem of heat-induced reactions in fats. The present status of this work as published is, at best, confusing. There is a great need for basic research in this area, i.e., what basic reactions occur when a food fat is heated, especially at the temperatures used, for example, in frying operations, and what is the nutritional status of used fats and oils?

In the discussion which followed, the question was asked, "To what degree does polymerization occur in the deodorizing process, and to what degree does it vary with the temperature and type of oil?"

Dr. Mattil remarked that in recognition of these problems we need to consider "What is the reality of the situation from a practical point of view?" We need to know how to measure polymerization of fats, how to prevent it, and what its real significance is. He stated that information developed on this should be published in its proper prespective and in a manner so as not to mislead.

Dr. Dutton stated that the Europeans were using polymerized fat as an emulsifier in margarine and contributed to much of the controversy in this area.

Vegetable Oils

Mr. S. J. Rini addressed the group on uses of vegetable oils, new oilseed crops, new oilseed strains, and use of unhydrogenated soybean oil. In reviewing increased use of soybean oil in the last several years, he stated that in the past a limit of 20% was the rule in margarine manufacturing, but this is no longer true since hydrogenation permits the use of larger quantities. Unhydrogenated soybean oil is a different problem, since its odor is highly undesirable. He pointed out that the consumption of salad oils has been going up; that supplies of cottonseed oil, etc. are limited and the logical one to turn to is soybean oil, but that much more research is needed on soybean oil for these uses. "If, for example, hydrogenation should prove to be deleterious nutritionwise, what would be the position of soybean oil on the market as a food fat?" he asked. He suggested that linolenic acid in the soybean oil is probably the precursor of the "painty" and "fishy" odors.

Mr. Rini asked the question, "Can we blend oilseed strains for quality instead of quantity?" In thinking of new oilseed crops, blending of strains could have many advantages. An ideal oil protein crop should furnish a large amount of protein as well as other generally desired qualities such as built-in antioxidants.

Closing Remarks

Dr. Mattil expressed the appreciation of the Committee to the ARS representatives for presenting their programs and listening to industry's pleas for help. He gave a strong endorsement of the ARS program and offered the cooperation of the Technical Committee in any way to help any of these projects where possible. He expressed hope for subsequent visits and informal meetings of this sort.

Dr. Hopper asked whether the Committee would be willing to submit known samples of products which could be used in the work they are carrying on, such as other industries have done. Dr. Mattil advised that samples of this sort have been supplied in the National Institutes of Health program through the Institute's office, and that a similar arrangement could probably be made for the needs of the Regional Laboratories of ARS.

Dr. Matchett closed the meeting by expressing, on behalf of the ARS representatives, appreciation for this opportunity to exchange ideas on the fats and oils research. Further, he stated that the utilization research groups would welcome any formalized suggestions the Committee may wish to offer and that these USDA utilization groups would look forward to continued liaison with the Institute and its Technical Committee.

Attachment

WESTERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

Dr. George Kohler told the group that the Western Division has not had a research program on fats and oils until the very recent transfer of the castor research from SU to WU. Up to the present time, WU research has been limited to studies of fatty constituents in various commodities such as poultry meat, eggs, cereal grains, and in certain fruits and vegetables.

Dr. Goldblatt briefly reviewed some of the castor oil research which he had done while at SU and which will now be a part of the WU program. This work has progressed along three lines, namely: (1) preparation and evaluation of urethane polymers based on castor oil; (2) preparation, characterization and evaluation of various nitrogen-containing derivatives of ricinoleic acid, the chief component of castor oil; and (3) the basic chemistry of the beta-hydroxy-ene system of ricinoleic acid. It was found that low-density polyurethane foams could be made with up to about 80% castor oil. A simple process for elaidinizing castor oil was developed. Polyurethan foams made from elaidinized castor oil were found to shrink less and to be more water-resistant than comparable foams made from normal castor oil. Several nitrogen derivatives of ricinoleic acid were found to be compatible plasticizers for polyvinyl chloride and cellulose acetate plastics. An analysis of shifts in position of maximum infrared absorption and in molecular absorptivity of ricinelaidic acid and several derivatives indicated some interaction between the hydroxyl group and double bond of the beta-hydroxy-ene system.

Preservation and Chemistry of Shelled Walnuts: Cooperative studies with Diamond Walnut Growers, Inc., of Stockton, California, have been in progress for the past several years on the development of a process for preserving the quality of shelled walnuts to increase their shelf life. The basic problem has been to control environmental factors such as heat, light, moisture and oxygen, which cause the development of darkening and rancidity in stored kernels.

Studies have been directed toward determining the specific chemical mechanisms which cause rancidity in stored walnut kernels. Results have indicated that carbonyl compounds may be involved during deterioration of kernels giving them a stale or rancid odor. Other studies have shown that tannin compounds present in the pellicle exert an antioxidant effect on the kernel oil.

Stability of Precooked Frozen Poultry Products Under Various Temperature Conditions. Frozen Fried Chicken: Study of the stability of frozen fried chicken has shown the importance of several factors in off-flavor development, the types of flavor changes that occur, the conditions that produce off-flavor development sufficient to cause consumer dissatisfaction, and methods of increasing stability to the extent needed in our present food distribution system.

Improved Frozen Salad Dressing: Studies are in progress on the development of an egg-yolk-containing salad dressing that can be frozen without separation of the oil phase. To date the most stable products have been obtained by the use of waxy rice flour as the thickening agent. The type of oil used in the emulsion also appears to have some effect on the stability at various storage temperatures. Additives of a type that produce a gel structure are the most promising means of obtaining a desirable consistency. These and other formulation changes are being studied for their effectiveness in producing a salad dressing that will be satisfactory for use on frozen salads and sandwiches and that would prevent the damage caused by unintentional freezing of salad dressings.

Recent WU Publications

1. "Time-Temperature-Tolerance of Frozen Foods. XII. Turkey Dinners and Turkey Pies." H. L. Hanson and L. R. Fletcher. Food Technol. 12, 40-43 (1958).

2. "Time-Temperature-Tolerance of Frozen Foods. XVII. Fried Chicken." H. L. Hanson, L. R. Fletcher, and H. Lineweaver. Food Technol. 13, 221-223 (1959).

3. "A New Treatment of Hygroscopic Equilibria; Application to Walnuts (Juglans regia) and Other Foods." L. B. Rockland. Food Research 22, 604-628 (1959).

Recent WU Patents

1. Preservation of Walnuts. L. B. Rockland. U. S. Patent 2,816,839, December 17, 1959.